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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/033,669	12/28/2001	Junichi Fujikata	SHM-01901	7978

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EXAMINER	
BERNATZ, KEVIN M	
ART UNIT	**PAPER NUMBER**
1773	

DATE MAILED: 04/22/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/033,669	FUJIKATA ET AL.	
	Examiner	Art Unit	
	Kevin M Bernatz	1773	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-16 and 23-29* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-16 and 23-29* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. Amendments to the specification and claims 1,3,5,6 and 16-23, filed on October 21, 2003, have been entered in the above-identified application.

2. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claim Rejections - 35 USC § 103

3. Claims 1, 2, 5 and 7 – 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. (U.S. Patent No. 6,335,081 B1) in view of Araki et al. (U.S. Patent No. 6,483,675 B1) and Suzuki (JP 10-162320 A), and further ***as evidenced by Portier et al. (App. Phys. Let., 79(1), 2001, 57 – 59)***. See U.S. Patent No. 6,084,405 which is the U.S. equivalent of JP '320 A.

Regarding claims 1, 3, 5 and 6, a comparison between the claimed and prior art structure is best illustrated by the following table:

Claim 1	Araki: bottom AF	Claim 5	Araki: top AF
Upper electrode	Layer 75	Upper electrode	Layer 95
2nd magnetic	Layer 20	Antiferromagnetic	Layer 50
Tunnel barrier	Layer 30	1st magnetic	Layer 40
1st magnetic	Layer 40	Tunnel barrier	Layer 30
Antiferromagnetic	Layer 50	2nd magnetic	Layer 20
Under layer	Layer 8	Under layer	Layer 8
Lower electrode	Layer 71	Lower electrode	Layers 101/91
substrate	substrate	Substrate	Substrate

The Examiner notes that the Araki et al. ('081 B1) structures are disclosed in Figures 1 and 2, as well as col. 6, lines 47 – 56.

As can be seen above, Araki et al. ('081 B1) disclose structures meeting applicants' claimed limitations for the embodiments in claims 1 and 5. Araki et al. ('081 B1) further teach underlayer materials meeting applicants' claimed limitation, e.g. "Ta" (*col. 2, lines 28 – 43 and 58 – 59 and Examples*).

Regarding the limitation "the second magnetic thin film, being non-adjacent to said antiferromagnetic layer, contacts a permanent magnetic film magnetically oriented in the direction of said axis of easy magnetization of the second magnetic film", Araki et al. ('081 B1) disclose that the second magnetic film can either be a multilayer film possessing two magnetic layers laminated in direct contact with each other (*col. 6, lines 26 – 28*), or a biasing permanent magnetic layer (*Suzuki, col. 6, lines 3 – 12*) can be placed at the ends of the second ferromagnetic layer to exchange bias the

magnetization direction of the second magnetic film (*col. 8, lines 13 – 20 and Figure 3, elements 61*). The Examiner notes that AFM and permanent magnets are known equivalent biasing means as evidenced by the Suzuki cite above. The Examiner further notes that the magnetization direction of the two exchange coupled films necessarily be in the same direction since the films are exchange coupled to each other, especially since the reason for the bias layer is specifically to force the magnetization directions to be the same as in the biasing layer in the area where the films are exchange coupled.

In the instant case, the claimed and prior art products are substantially identical in structure and composition, as shown in the table above. Furthermore, it is noted that the exchange coupling force between the first magnetic film and the antiferromagnetic film is effected by the surface bonding between the two layers: improved bonding leads to increased exchange coupling, ***as evidenced by Portier et al. (page 59, underlined sections)***.

Therefore, in addition to the above disclosed limitations, the presently claimed properties of "Hr and Hc2 satisfy the relationship of Hc2 <Hr" (claims 1 and 5) would have necessarily resulted from the disclosed structure because the Examiner has sound basis for believing that the improved bonding would lead to improved exchange coupling as evidenced above.

Araki et al. ('081 B1) fail to teach the limitation "wherein an axis of easy magnetization of the first magnetic thin film is substantially perpendicular to an axis of easy magnetization of the second magnetic thin film".

However, Suzuki teaches that a magnetoresistive transducer possessing a large linear response and free of strong pinning of the second ferromagnetic layer in the direction parallel to the signal magnetic fields (*col. 3, liens 25 – 35*) can be formed by insuring that the magnetization of the pinned magnetic layer (i.e. applicants' "first magnetic layer") is perpendicular to the magnetization of the free magnetic layer (i.e. applicants' "second magnetic layer') (*Figure 7, layers 1 and 3 – noting element P31*).

It would, therefore, have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Araki et al. ('081 B1) to utilize a first and second magnetic layer meeting applicants' claimed magnetization limitations as taught by Suzuki since such a structure produces a magnetoresistive transducer possessing a large linear response and free of strong pinning of the second ferromagnetic layer in the direction parallel to the signal magnetic fields.

Regarding the limitations in surface roughness in claims 1, 2 and 5, Araki et al. ('675) teach that it is important to control the surface roughness of the tunnel barrier layer by controlling the surface roughness of "the layers which have been formed before forming the tunnel barrier layer" (*col. 3, lines 5 – 7 and col. 6, lines 22 - 29*) to surface roughness values meeting applicants' claimed range (*col. 2, lines 26 – 39*). Araki et al. ('675) further teach that a smooth tunnel barrier layer possess good MR ratio and no pin-holes (*col. 1, line 47 bridging col. 2, line 11*).

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Araki et al. ('081) in view of Suzuki to possess surface roughness values meeting applicants' claimed limitations as taught by

Araki et al. ('675), since it is known that controlling the surface roughness of the layers formed before the tunnel barrier layer will allow for the formation of a smooth tunnel barrier layer possessing good MR ratio and no pin-holes.

Regarding claims 7 – 11, Araki et al. ('081 B1) disclose materials and thickness values meeting applicants' claimed limitations for the AFM layer (*PtMn – example 1*), underlayer (*100 Å Ta – col. 5, lines 56 – 61 and example 1*), tunnel barrier layer (*5 – 20 Å AlOx – col. 6, lines 28 - 35*) and magnetic layers (*NiFe and FeCo – col. 5, line 66 bridging col. 6, line 16 and Example 1*).

4. Claims 3, 4, 6 and 14 – 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. ('081 B1) in view of Araki et al. ('675 B1), Suzuki and as evidenced by Portier et al. as applied above, and further in view of Gill (U.S. Patent No. 6,127,045) and Park et al. (IEEE. Trans. Mag., 35(5), 1999, 2919 – 2921).

Regarding claims 3, 4 and 6, Araki et al. ('081 B1), Araki et al. ('675 B1), Suzuki and Portier et al. are relied upon as described above. Araki et al. ('081 B1) further disclose replacing the pinned layer with a synthetic layer in antiferromagnetic coupling: i.e. magnetic/ non-magnetic / magnetic (*col. 6, lines 17 – 27*).

Araki et al. fail to disclose a structure meeting applicants' claimed limitations, specifically embodiments comprising a synthetic "pinned layer" and an additional magnetic layer adjacent to the tunnel barrier layer, i.e. "3rd magnetic/non magnetic/4th magnetic/1st magnetic".

Claim 3	Araki: bottom AF	Claim 6	Araki: top AF
Upper electrode	Layer 75	Upper electrode	Layer 95
2nd magnetic	Layer 20	Antiferromagnetic	Layer 50
Tunnel barrier	Layer 30	3rd magnetic	CoFe
1st magnetic	--	Non magnetic	Ru
4th magnetic	CoFe	4th magnetic	CoFe
Non magnetic	Ru	1st magnetic	--
3rd magnetic	CoFe	Tunnel barrier	Layer 30
Antiferromagnetic	Layer 50	2nd magnetic	Layer 20
Under layer	Layer 8	Under layer	Layer 8
Lower electrode	Layer 71	Lower electrode	Layers 101/91
substrate	substrate	substrate	Substrate

However, Park et al. teach that it is known in the art to use interface layers between the free and pinned layers inorder to improve the MR ratio (*Abstract, page 2919 – underlined sections*) and Gill teaches that these interface layers can also be used adjacent to synthetic antiferromagnetically coupled layers (*col. 5, lines 46 – 54*).

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Araki et al. ('081 B1), Araki et al. ('675 B1), Suzuki and Portier et al. to insert a "first magnetic" interface layer between the synthetic "third magnetic" / "non-magnetic" / "fourth magnetic" pinned layers disclosed by Araki et al. ('081 B1), since Park et al. and Gill teach that such an interface layer results in an improved MR ratio.

Regarding claims 14 and 15, Araki et al. disclose ferromagnetic materials (*FeCo – col. 6, lines 23 – 25*) and non-magnetic materials + thickness values (*7 Å Ru - col. 6, lines 23 - 25*) meeting applicants' claimed limitations for the synthetic pinned layer structure.

Regarding claim 16, both Park et al. and Gill disclose interface materials and thickness values meeting applicants' claimed composition and thickness limitations (*Gill: col. 6, lines 49 – 50 and 56 – 58; Park et al.: Figure 1*).

5. Claims 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. ('081 B1) in view of Araki et al. ('675 B1), Suzuki and as evidenced by Portier et al. as applied above, and further in view of Hayashi (U.S. Patent No. 5,849,422).

Regarding claims 12 and 13, Araki et al. ('081 B1), Araki et al. ('675 B1), Suzuki and Portier et al. are relied upon as described above. Araki et al. ('081 B1) further disclose a lower electrode layer comprising a magnetic material having a shield effect (*Figure 2, layer 91 –"common lead and shield layer **91** (NiFe", example 1*) and a non-magnetic material (*layer 101 – "Rh"*).

Araki et al. ('081 B1) fail to disclose using an amorphous CoZr alloy as the magnetic material of layer 91.

However, Suzuki teaches that amorphous CoZr alloy magnetic materials are equivalent magnetic materials for the soft magnetic layer provided between the antiferromagnetic layer and the substrate (*Figure 7, layers 4, 24 and 6; col. 8, line 45*

bridging col. 9, line 1; and col. 12, lines 16 - 17) and Hayashi et al. teach that the choice of an amorphous CoZr alloy is preferred because "good magnetic characteristics can be obtained even in the case where special attention is not paid to the back pressure during the film formation and target purity as compared to the case where NiFe and others are used" (*col. 3, lines 43 – 55*).

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Araki et al. ('081 B1), Araki et al. ('675 B1), Suzuki and Portier et al. to include an amorphous CoZr alloy as layer 91 as taught by Suzuki and Hayashi, since "good magnetic characteristics can be obtained even in the case where special attention is not paid to the back pressure during the film formation and target purity as compared to the case where NiFe and others are used".

6. Claims 23 - 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. ('081 B1) in view of Araki et al. ('675 B1), Suzuki and as evidenced by Portier et al. as applied above, and further in view of Redon et al. (U.S. Patent No. 6,519,124 B1) and Sun et al. (U.S. Patent App. No. 2002/0097534 A1).

Araki et al. ('081 B1), Araki et al. ('675 B1), Suzuki and Portier et al. are relied upon as described above. Araki et al. ('081 B1) further disclose forming the elements into square shapes meeting applicants' claimed size limitations (*"the size of the TMR element actually used is about (0.15 μm x 0.15 μm) to (1 μm x 1 μm)" – col. 10, lines 15 – 16*).

Regarding claim 23, Araki et al. ('081 B1) fail to disclose the resistance of the element.

However, Araki et al. ('081 B1) teach that it is known in the art that the resistance is desired to be low, but that the lower the resistance, the harder it is to form the tunnel barrier layer (*col. 1, line 45 bridging col. 2, line 9*). Redon et al. also teach that there is "a trade-off between high TMR ratio and MTJ resistance" (*col. 2, line 66 bridging col. 3, line 21*), with typical resistance values ranging from 15 Ω and up, though it is the 'resistance x area' product, RA, which is most critical (*col. 2, lines 13 – 21*). Finally, Sun et al. provides data indicating ranges in resistance obtainable for various tunnel barrier layer thickness values (*Figure 5A and 5B*).

Therefore, Araki et al. ('081 B1), Redon et al. and Sun et al. all teach the importance of optimizing the resistance for improved MR ratio and no pin-holes. The Examiner deems that it would have been obvious to one having ordinary skill in the art to have determined the optimum value of a cause effective variable such as the resistance of the MR element through routine experimentation, especially given the teachings in the art cited above regarding the desire to optimize the resistance to produce a MR element with a good MR ratio, good RA product, and without any pin-hole effects. *In re Boesch*, 205 USPQ 215 (CCPA 1980); *In re Geisler*, 116 F. 3d 1465, 43 USPQ2d 1362, 1365 (Fed. Cir. 1997); *In re Aller*, 220 F.2d, 454, 456, 105 USPQ 233, 235 (CCPA 1955).

Regarding claims 24 and 25, Araki et al. ('081 B1) disclose supplying a bias means adjacent to said "second" magnetic thin film, i.e. the "free" layer (*col. 8, lines 8 –*

20), but Araki et al. ('081 B1) fail to disclose whether the "second" magnetic thin film is in a single domain state.

However, Suzuki teaches that it is known in the art to apply the bias to keep the adjacent ferromagnetic layer in the single domain state (*col. 9, line 65 bridging col. 10, line 6*) and that such a bias can shift the resistance curve and widen the dynamic range (*col. 10, lines 39 – 46*).

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Araki et al. to use a bias means to hold the free magnetic layer into a single domain state as taught by Suzuki, since such a bias means results in a wider dynamic range for the MR element.

Regarding claim 25, Suzuki et al. disclose that an antiferromagnetic layer is a preferred means for applying the bias (*col. 9, lines 64 – 67*).

Regarding claim 26, Araki et al. disclose a shielded-type MR sensor comprising soft magnetic material having shielding effect which sandwiches on top and bottom the claimed MR element (*Figures 2 and 3 – layers 91 and 95 and col. 7, lines 44 – 65*).

7. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. ('081 B1) in view of Araki et al. ('675 B1), Suzuki, Redon et al., Sun et al. and as evidenced by Portier et al. as applied above, and further in view of Coehoorn et al. (IEEE Trans. Mag., 35(5), 1999, 2586 – 2588).

Araki et al. ('081 B1), Araki et al. ('675 B1), Suzuki, Redon et al., Sun et al. and Portier et al. are relied upon as described above.

None of the above disclose using the MR element in a yoke-type sensor.

However, Coehoorn et al. teach that yoke-type magnetic sensors comprising TMR elements and soft-magnetic films are known in the art to possess intrinsically lower noise than shield-type magnetic heads (*Introduction and Figures*).

The limitations "in which a signal field is guided to a spin tunnel magnetoresistive effect element" and "having shield effect" are functional limitation(s). In the instant case, the claimed limitation(s) are deemed to necessarily result from the disclosed "yoke-type" MR head structure since the claimed and prior art yoke-type heads are substantially identical in composition and/or structure. The examiner's sound basis for this assertion is that Coehoorn et al. disclose yoke-type heads using tunnel MR elements (*Figure 1*), wherein the flux guides are soft magnetic materials (*Figure 2*) and soft magnetic materials are known in the art to be used as shield layers in shield-type magnetic heads (*example 1*).

8. Claims 28 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. ('081 B1) in view of Araki et al. ('675 B1), Suzuki, Redon et al., Sun et al. and as evidenced by Portier et al. as applied above, and further in view of Gill ('045).

Araki et al. ('081 B1), Araki et al. ('675 B1), Suzuki, Redon et al., Sun et al. and Portier et al. are relied upon as described above.

None of the above disclose the apparatus limitations in claims 28 and 29.

However, Gill teaches that it is known in the art to utilize MR sensors comprising spin tunnel MR effect elements (*Figure 3, element 321 and col. 4, lines 57 - 60*)

possessing "means for detecting a resistance change ratio of said spin valve tunnel magnetoresistive effect element as a function of a detected magnetic field" (claim 28) (*col. 2, lines 5 – 37*), a "magnetic recording medium onto which information is recorded" (claim 29) (*Figure 3, element 312 and col. 4, lines 50 - 56*), a MR sensor which "plays back information recorded on said magnetic recording medium" (claim 29) (*col. 4, line 45 bridging col. 5, line 28*), and "an actuator for the purpose of controlling movement of said magnetoresistive sensor to a selected position on said magnetic recording medium" (claim 29) (*Figure 3, element 327 and col. 4, lines 63 - 67*), inorder to detect a signal from a recording medium and read/write to/from the medium.

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Araki et al. ('081 B1), Araki et al. ('675 B1), Suzuki, Redon et al., Sun et al. and Portier et al. to meet applicants' claimed structural limitations as taught by Gill since such limitations are necessary components of magnetic heads inorder to detect a signal from a recording medium and read/write to/from the medium.

Response to Arguments

9. The rejection of claims 1 – 16 and 23 - 29 under 35 U.S.C § 102(a) and 103(a) – Fujikata et al., alone or in combination with various references

The above noted rejection has been withdrawn in view of applicant(s) arguments, which have been found persuasive. Specifically, applicant(s) argue that Fujikata et al. is

not applicable since applicants have perfected their claim for priority, which antedates the filing date of the Fujikata et al. reference.

10. The rejection of claims 1 – 16 and 23 - 29 under 35 U.S.C § 103(a) – Araki et al. ('081 B1) in view of various references

Applicant(s) arguments have been considered but are moot in view of the new ground(s) of rejection. In so far as they apply to the present rejection of record, applicant(s) argue Portier et al. is not available as prior art based on applicants' perfected priority date. The Examiner respectfully disagrees.

Applicants are reminded that references which do not qualify as prior art because they postdate the claimed invention may be relied upon to either show material characteristics or properties, or to show the level of ordinary skill in the art at or around the time the invention was made (MPEP § 2124). In the instant case, Portier et al. is merely cited to show that exchange coupling is effected by the bonding quality between two layers.

Applicants further argue that "by controlling the axes of magnetization of the magnetic thin films in this manner, Applicants (*sic*) have found that Barkhausen noise can be suppressed" (*page 18 of response*). The Examiner notes that the use of biasing layers to form single domain states in adjacent magnetic layers is known in the art to suppress Barkhausen noise (which is generated by the existence of multiple domains in soft magnetic films). Any argument of unexpected results should be directed to a

comparison versus the closest prior art with a *detailed explanation* of why applicants feel the results are unexpected versus the knowledge in the art.

Conclusion

11. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Applicants' amendment resulted in embodiments not previously considered (i.e. "wherein an axis of easy magnetization of the first magnetic thin film ... of the second magnetic thin film.") which necessitated the new grounds of rejection, and hence the finality of this action.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kevin M Bernatz whose telephone number is (571) 272-1505. The examiner can normally be reached on M-F, 9:00 AM - 6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Paul Thibodeau can be reached on (571) 272-1516. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

KMB
April 12, 2004

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